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CLAIMS

2 WHAT IS CLAIMED IS:

3 1. An earth boring bit comprising:

4 a) a bit body having a longitudinal bit axis and a bit diameter;

5 b) at least one rolling cone cutter rotatably mounted on the bit body and having an

6 offset of its rotational axis from the bit axis of:

1) at least $1/8$ inch when the bit diameter is less than 4 inches,

2) at least $5/32$ inches when the bit diameter is 4 inches or greater and less than 5
inches,

3) at least $1/4$ inches when the bit diameter is 5 inches or greater and less than 7
inches,

4) at least $11/32$ inches when the bit diameter is 7 inches or greater and less than 9
inches,

5) at least $13/32$ inches when the bit diameter is 9 inches or greater and less than 12
inches,

15 6) at least $7/16$ inches when the bit diameter is 12 inches or greater and less than 16
inches, and

16 7) at least $17/32$ inches when the bit diameter is at least 16 inches; and

17 c) at least one super-abrasive cutter element located on the rolling cone cutter and

18 extending to full gage diameter.

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20 2. The bit of claim 1 wherein the amount of offset is:

- 1 a) at least $5/32$ inches and less than $3/16$ inches when the bit diameter is less than 4 inches,
- 2 b) at least $3/16$ inches and less than $1/4$ inches when the bit diameter is at least 4 inches and
3 less than 5 inches,
- 4 c) at least $9/32$ inches and less than $5/16$ inches when the bit diameter is at least 5 inches
5 and less than 7 inches,
- 6 d) at least $3/8$ inches and less than $7/16$ inches when the bit diameter is at least 7 inches
7 and less than 9 inches,
- 8 e) at least $15/32$ inches and less than $9/16$ inches when the bit diameter is at least 9 inches
9 and less than 12 inches,
- 10 f) at least $19/32$ inches and less than $3/4$ inches when the bit diameter is at least 12 inches
11 and less than 16 inches, and
- 12 g) at least $3/4$ inches and less than 1 inch when the bit diameter is at least 16 inches.

3. The bit of claim 1 wherein the amount of offset is:

15 a) at least 3/16 inches when the bit diameter is less than 4 inches,
16 b) at least 1/4 inches when the bit diameter is at least 4 inches and less than 5 inches,
17 c) at least 5/16 inches when the bit diameter is at least 5 inches and less than 7 inches,
18 d) at least 7/16 inches when the bit diameter is at least 7 inches and less than 9 inches,
19 e) at least 9/16 inches when the bit diameter is at least 9 inches and less than 12 inches,
20 f) at least 5/8 inches when the bit diameter is at least 12 inches and less than 16 inches, and
21 g) at least 1 inch when the bit diameter is at least 16 inches.

1 4. The bit of claim 1 wherein the super-abrasive cutter element comprises a polycrystalline
2 diamond coated insert.

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4 5. The bit of claim 1 wherein the super-abrasive cutter element comprises a cubic boron nitride
5 coated insert.

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6. The bit of claim 1 wherein the super-abrasive cutter element is located on the gage row of
the cone cutter.

7. The bit of claim 1 wherein the super-abrasive cutter element is located on a secondary gage
row of the cone cutter.

8. The bit of claim 1 wherein the super-abrasive cutter element is located on a heel row of
the cone cutter.

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16 9. The bit of claim 1 wherein the cone cutter has a journal angle of about 33° or less.

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18 10. The bit of claim 1 wherein the bit is a soft to medium-hard formation insert bit.

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20 11. The bit of claim 10 wherein the bit has an IADC classification of 6-2-x or lower series
21 number.

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1 12. The bit of claim 11 wherein the bit has an IADC classification of 4-4-x or lower series
2 number.

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4 13. The bit of claim 1 wherein the bit is a milled tooth bit.

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6 14. The bit of claim 13 wherein the bit has an IADC classification of 2-3-x or lower series
7 number.

15. The bit of claim 14 wherein the bit has a IADC classification of 1-3-x or lower series
number.

16. The bit of claim 1 further comprising a super-abrasive cutter element located on an off-gage
row of the cone cutter.

15 17. The bit of claim 1 further comprising a super-abrasive cutter element located on an inner
16 row of the cone cutter.

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18 18. The bit of claim 1 wherein there are three rolling cone cutters, each of which is offset.

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20 19. The bit of claim 18 wherein each of the three cone cutters has substantially the same
21 amount of offset.

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1 20. The bit of claim 1 wherein there are super-abrasive cutter inserts located on both a gage row
2 and a heel row of the rolling cone cutter.

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4 21. An earth boring bit comprising:

5 a) a bit body having a longitudinal bit axis and a bit diameter;
6 b) at least one rolling cone cutter rotatably mounted on the bit body and having an
7 offset of its rotational axis from the bit axis of:

- 1) at least 1/8 inch when the bit diameter is less than 4 inches,
- 2) at least 5/32 inches when the bit diameter is 4 inches or greater and less than 5
inches,
- 3) at least 1/4 inches when the bit diameter is 5 inches or greater and less than 7
inches,
- 4) at least 11/32 inches when the bit diameter is 7 inches or greater and less than 9
inches,
- 5) at least 13/32 inches when the bit diameter is 9 inches or greater and less than 12
inches,
- 6) at least 7/16 inches when the bit diameter is 12 inches or greater and less than 16
inches, and
- 7) at least 17/32 inches when the bit diameter is at least 16 inches; and

20 c) at least one super-abrasive cutter element located on the cone cutter.

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22 22. The bit of claim 21 wherein the amount of offset is:

- a) at least $\frac{5}{32}$ inches and less than $\frac{3}{16}$ inches when the bit diameter is less than 4 inches,
- b) at least $\frac{3}{16}$ inches and less than $\frac{1}{4}$ inches when the bit diameter is at least 4 inches and less than 5 inches,
- c) at least $\frac{9}{32}$ inches and less than $\frac{5}{16}$ inches when the bit diameter is at least 5 inches and less than 7 inches,
- d) at least $\frac{3}{8}$ inches and less than $\frac{7}{16}$ inches when the bit diameter is at least 7 inches and less than 9 inches,
- e) at least $\frac{15}{32}$ inches and less than $\frac{9}{16}$ inches when the bit diameter is at least 9 inches and less than 12 inches,
- f) at least $\frac{19}{32}$ inches and less than $\frac{3}{4}$ inches when the bit diameter is at least 12 inches and less than 16 inches, and
- g) at least $\frac{3}{4}$ inches and less than 1 inch when the bit diameter is at least 16 inches.

23. The bit of claim 21 wherein the amount of offset is:

- a) at least 3/16 inches when the bit diameter is less than 4 inches,
- b) at least 1/4 inches when the bit diameter is at least 4 inches and less than 5 inches,
- c) at least 5/16 inches when the bit diameter is at least 5 inches and less than 7 inches,
- d) at least 7/16 inches when the bit diameter is at least 7 inches and less than 9 inches,
- e) at least 9/16 inches when the bit diameter is at least 9 inches and less than 12 inches,
- f) at least 3/4 inches when the bit diameter is at least 12 inches and less than 16 inches, and
- g) at least 1 inch when the bit diameter is at least 16 inches.

1 24. The bit of claim 21 wherein the super-abrasive cutter element extends at least to near gage
2 diameter.

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4 25. The bit of claim 21 wherein the super-abrasive cutter element is located on an inner row of
5 the rolling cone cutter.

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26. The bit of claim 25 wherein the super-abrasive cutter element comprises a polycrystalline
diamond coated insert.

27. The bit of claim 21 wherein the super-abrasive cutter element extends to substantially full
gage diameter.

28. The bit of claim 22 wherein the super-abrasive cutter element comprises a polycrystalline
diamond coated insert.

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16 29. The bit of claim 23 wherein the super-abrasive cutter element comprises a polycrystalline
17 diamond coated insert.

18

19 30. A hard to extremely hard formation-type earth boring bit having an IADC numeric
20 nomenclature of 6-3-x or higher and comprising:

21 a) a bit body having a longitudinal bit axis and a bit diameter;
22 b) at least one rolling cone cutter rotatably mounted on the bit body and having an

1 offset of its rotational axis from the bit axis of:

3 2) at least 3/32 inches when the bit diameter is at least 7 inches and less than 12
4 inches,

5 3) at least 5/32 inches when the bit diameter is at least 12 inches; and

6 c) at least one superabrasive cutter element located on the cone cutter.

31. The bit of claim 30 wherein the super-abrasive cutter element is located on an inner row of the rolling cone cutter.

32. The bit of claim 30 wherein the super-abrasive cutter element extends to at least near gage diameter.

33. The bit of claim 32 wherein the super-abrasive cutter element comprises a polycrystalline diamond coated insert.

17 34. The bit of claim 30 wherein the amount of offset is:

18 a) at least 3/32 inches and less than 1/8 inches when the bit diameter is less than 7
19 inches.

20 b) at least 5/32 inches and less than 7/32 inches when the bit diameter is at least 7
21 inches and less than 12 inches, and

22 c) at least 7/32 inches and less than 9/32 inches when the bit diameter is at least 12

1 ~~inches.~~

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3 35. The bit of claim 34 wherein the super-abrasive cutter element comprises a polycrystalline
4 diamond coated insert.

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6 36. The bit of claim 30 wherein the amount of offset is:

- 7 a) at least 1/8 inches when the bit diameter is less than 7 inches,
- 8 b) at least 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches,
9 and
- 10 c) at least 9/32 inches when the bit diameter is at least 12 inches.

11 37. The bit of claim 36 wherein the super-abrasive cutter element comprises a polycrystalline
12 diamond coated insert.

13 38. The bit of claim 30 wherein the cone cutter has a journal angle of about 36° or more.

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15 39. The bit of claim 32 wherein the super-abrasive cutter element is located on a gage row of
16 the rolling cone cutter.

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18 40. The bit of claim 32 wherein the super-abrasive cutter element is located on a secondary
19 ~~gage row of the rolling cone cutter.~~

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1 41. The bit of claim 32 wherein the super-abrasive cutter element is located on a heel row of the
2 rolling cone cutter.

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4 42. The bit of claim 39 further comprising a super-abrasive cutter element located on the inner
5 row of the rolling cone cutter.

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43. The bit of claim 30 wherein the super-abrasive cutter element comprises a cubic boron
nitride coated insert.

44. A medium-hard to extremely hard formation-type earth boring bit comprising:
a) a bit body having a longitudinal bit axis and a bit diameter;
b) at least one rolling cone cutter rotatably mounted on the bit body and having an
offset of its rotational axis from the bit axis of:
4) at least 1/16 inches when the bit diameter is less than 7 inches,
5) at least 3/32 inches when the bit diameter is at least 7 inches and less than 12
inches,
6) at least 5/32 inches when the bit diameter is at least 12 inches; and
c) a journal angle being formed between the rotational axis and the bit axis of at least
36°;
d) at least one super-abrasive cutter element located on an inner row of the cone cutter.

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22 45. The bit of claim 44 wherein the super-abrasive cutter element comprises a polycrystalline

1 diamond coated insert.

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3 46. The bit of claim 44 wherein the super-abrasive cutter element comprises a cubic boron
4 nitride coated insert.

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47. The bit of claim 44 wherein the amount of offset is:

- a) at least 3/32 inches and less than 1/8 inches when the bit diameter is less than 7 inches,
- b) at least 5/32 inches and less than 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches, and
- c) at least 7/32 inches and less than 9/32 inches when the bit diameter is at least 12 inches.

48. The bit of claim 44 wherein the amount of offset is:

- a) at least 1/8 inches when the bit diameter is less than 7 inches,
- b) at least 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches, and
- c) at least 9/32 inches when the bit diameter is at least 12 inches.

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20 49. The bit of claim 44 wherein the bit comprises an insert bit having an IADC classification of
21 6-1-x or higher series number.

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1 30. The bit of claim ~~44~~ further comprising a super-abrasive cutter element located on a gage
2 row of the rolling cone cutter.

3 31. The bit of claim ~~44~~ further comprising a super-abrasive cutter element located on a
4 secondary gage row of the rolling cone cutter.
5

6 32. The bit of claim 44 further comprising a super-abrasive cutter element located on a heel row
of the rolling cone cutter.

10 33. The bit of claim 44 further comprising super-abrasive cutter elements located on all the
inner rows of all the rolling cone cutters.